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RPP-22393, Rev. 2B

C-102, C-104, C-107, C-108, and C-112 Tanks Waste Retrieval Work Plan

JS Schofield
CH2M Hill Hanford Group, Inc.
Richland, WA 99352
U.S. Department of Energy Contract DE-AC27-99RL-14047

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Key Words: 241-C-102, 241-C-104, 241-C-107, 241-C-108, 241-C-112, Retrieval, TWRWP, Sluicing

Abstract: This document establishes the 241-C-102, 241-C-104, 241-C-107, 241-C-108 and 241-C-112 Tanks Waste Retrieval Work Plan required by Hanford Federal Facility Agreement and Consent Order.

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APPROVED FOR PUBLIC RELEASE

Tank Farm Contractor (TFC) **RECORD OF REVISION**	(1) Document Number RPP-22393	1 Page

(2) Title: 241-C-102, 241-C-104, 241-C-107, 241-C-108, and 241-C-112 Tanks Waste Retrieval Work Plan

CHANGE CONTROL RECORD

(3) Revision	(4) Description of Change - Replace, Add and Delete Pages	Authorized for Release	
		(5) Resp. Engr. (print/sign/date)	(6) Resp. Mgr. (print/sign/date)
0	EDT-821231, Initial Release	RS Robinson 9/14/04	WT Thompson 9/14/04
1	Complete rewrite due to revised leak detection and monitoring strategy. Revision per ECN-722369.	RS Robinson 9-28-04	WT Thompson 9-28-04
2	Incorporation of Ecology comments. Major revision of document, all sections affected. ECN-722664-R0	RS Robinson 6/27/05	WT Thompson 6/27/05
2A	Incorporation of changes requested by DOE-ORP on pgs. 1-1, 2-1, 3-12, and 5-1 per ECN-723375 R0	RS Robinson 7/19/05	WT Thompson 7/19/05
RS 2B	Incorporation of changes requested by WDOE on pgs. 2-1, 2-4, 2-13 through 2-17, 3-2, 3-7, 3-18, 4-6 through 4-10, 4-12 and 4-13, A-4, B-4, C-4, D-4 and E-4 per ECN-723425 R0	JR Bellomy JR Bellomy 9/19/05	WT Thompson W.T. Thompson 9/19/05

CH2M HILL ENGINEERING CHANGE NOTICE	1a. ECN 723425 R 0
Page 1 of 2 ☒ DM ☐ FM ☐ TM	1b. Proj. ECN N/A - - R

2. Simple Modification	3. Design Inputs – For full ECNs, record information on the ECN-1 Form (not required for Simple Modifications)	4. Date
☒ Yes ☐ No		8/18/05

5. Originator's Name, Organization, MSIN, & Phone No.	6. USQ Number	7. Related ECNs
John Schofield, Closure Operations, S7-12, 373-2245	No. - - -DR- ☒ N/A	N/A

8. Title	9. Bldg. / Facility No.	10. Equipment / Component ID	11. Approval Designator
Change RPP-22393 Rev 2A to RPP-22393 Rev 2B	241-C	C-100 Series Tanks	ER

12. Engineering Documents/Drawings to be Changed (Incl. Sheet & Rev. Nos.)	13. Safety Designation	14. Expedited/Off-Shift ECN?
RPP-22393, Rev 2A	☐ SC ☐ SS ☐ GS ☒ N/A	☐ Yes ☒ No

15a. Work Package Number	15b. Modification Work Completed	15c. Restored to Original Status (TM)	16. Fabrication Support ECN?
N/A	N/A Responsible Engineer / Date	N/A Responsible Engineer / Date	☐ Yes ☒ No

17. Description of the Change (Use ECN Continuation pages as needed)

Replace pages 2-1, 2-4, 2-13 through 2-17, 3-2, 3-7, 3-18, 4-6 through 4-10, 4-12, 4-13, A-4, B-4, C-4, D-4 and E-4 in RPP-22393, Rev. 2A with attached new pages 2-1, 2-4, 2-13 through 2-17, 3-2, 3-7, 3-18, 4-6 through 4-10, 4-12, 4-13, A-4, B-4, C-4, D-4 and E-4 for RPP-22393, Rev 2B.

18. Justification of the Change (Use ECN Continuation pages as needed)

Additional wording changes required by Washington State Department of Ecology prior to approval of document.

No USQ evaluation required, this document does not implement any temporary or permanent changes to the facility or procedures. JSS 9/19/05

19. ECN Category

☒ Direct Revision
☐ Supplemental
☐ Void/Cancel

ECN Type

☐ Supercedure
☐ Revision

20. Distribution

Name	MSIN	Name	MSIN
KE Carpenter	S7-66	KJ Anderson	S7-6
SD Doss	S7-03	JF Bores	S7-0
RD Smith	S7-90	WF Zuroff	S7-6
RS Robinson	S7-67	WT Thompson	S7-6
RE Butler	S7-75	DB Parkman	S7-6
MN Jaraysi	H6-03	JJ Luke	H6-0
JS Schofield	S7-12	Central Files	B1-0

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Page 2 of 2 ☒ DM ☐ FM ☐ TM	1b. Proj. ECN N/A - - R

21. Revisions Planned (include a brief description of the contents of each revision)	22. Design Basis Documents
None are planned beyond Rev 2B at this time. Note: All revisions shall have the approvals of the affected organizations as identified in block 11 "Approval Designator," on page 1 of this ECN.	JJS 9/19/05 ~~☒ Yes~~ ☒ No

23. Commercial Grade Item Dedication Numbers (associated with this design change)	24. Engineering Data Transmittal Numbers (associated with this design change, e.g., new drawings, new documents)
N/A	N/A

25. Other Non Engineering (not in HDCS) documents that need to be modified due to this change

Type of Document	Document Number	Update Completed On	Responsible Engineer (print/sign and date)
Alarm Response Procedure	N/A		
Operations Procedure	N/A		
Maintenance Procedure	N/A		
Type of Document	**Document Number**	**Type of Document**	**Document Number**
N/A		N/A	

26. Field Change Notice(s) Used?		27. Design Verification Required?
☐ Yes ☒ No If Yes, Record Information on the ECN-2 Form, attach form(s), include a description of the interim resolution on ECN Page 1, block 17, and identify permanent changes.	NOTE: ECNs are required to record and approve all FCNs issued. If the FCNs have not changed the original design media then they are just incorporated into the design media via an ECN. If the FCN did change the original design media then the ECN will include the necessary engineering changes to the original design media.	☐ Yes ☒ No If Yes, as a minimum attach the one page checklist from TFC-ENG-DESIGN-P-17.

28. Approvals

	Facility/Project Signatures	Date		A/E Signatures	Date
Design Authority	NA		Originator/Design Agent	N/A	
Resp. Engineer	for J.R. Bellamy ~~RS Robinson~~ [signature]	9/19/05	Professional Engineer		
Resp. Manager	WT Thompson [signature]	9/19/05	Project Engineer		
Quality Assurance	N/A		Quality Assurance		
IS&H Engineer	N/A		Safety		
NS&L Engineer	N/A		Designer		
Environ. Engineer	by Env. Strategies below		Environ. Engineer		
Engineering Checker	MJ BRYDEN [signature]	9.19.05	Other		
Other	Project Manager KE Carpenter [signature]	9/19/05	Other		
Other	Env. Strategies MN Jaraysi [signature]	9/20/05	DEPARTMENT OF ENERGY / OFFICE OF RIVER PROTECTION		
Other	Rad Con RL Brown [signature]	9/19/05	Signature or a Control Number that tracks the Approval Signature		
Other	JS Schofield [signature]	9/19/05			
Other			ADDITIONAL SIGNATURES		
Other					
Other					

2.0 TANKS AND/OR ANCILLARY EQUIPMENT CONDITION AND CONFIGURATION AND WASTE CHARACTERISTICS

2.1 RETRIEVAL START DATES

A summary of the current schedule baseline for waste retrieval from the five tanks addressed in this document is provided in Figure 2-1. Current plans include initiating waste retrieval from tank C-108 in December 2005, tank C-112 in February 2006, tank C-107 in March 2006, tank C-102 in May 2006, and tank C-104 in June 2006. The schedule information provided in this document is current as of the first quarter of calendar year 2005. However, the schedules are subject to change due to the time required to resolve the technical challenges that arise in the field during retrieval. DOE will request any schedule changes using the Change Control Form in accordance with Section 12.0 of the HFFACO Action Plan. Changes to the start date that do not affect a major milestone will be considered Class II changes. As shown in Figure 2-1, waste retrieval is planned to be completed within 12 months of the waste retrieval start date for each tank in accordance with HFFACO Appendix I requirements. The waste retrieval durations are estimated based on planning assumptions for operating efficiency and performance of the waste retrieval system (WRS).

2.2 TANK HISTORY

This work plan addresses waste retrieval from five 100-series tanks, C-102, C-104, C-107, C-108, and C-112, located in the C tank farm in the 200 East Area (Figure 2-2). Summary-level historical data related to the configuration and operating history for these five tanks are provided in Table 2-1.

Each of these tanks is designated as sound in HNF-EP-0182. The designation of sound is based upon tank surveillance data that indicates no loss of liquid attributed to a breach of integrity. See Section 2.4 for a discussion of the basis for tank designation.

The C farm 100-series tanks are 75 ft in diameter and 32 ft tall. The tanks have a 16-ft operating depth and an operating capacity of 530,000 gal. each. The tanks sit belowgrade with soil cover to provide shielding from radiation exposure to operating personnel.

Table 2-1. Summary-Level Tank Data.

Tank	C-102	C-104	C-107	C-108	C-112
Constructed	1943-44	1943-44	1943-44	1943-44	1943-44
In service	1946	1946	1946	1947	1946
Diameter (ft)	75	75	75	75	75
Operating depth (in.)	185	185	185	185	185
Design capacity (gal.)	530,000	530,000	530,000	530,000	530,000
Bottom shape	Dish	Dish	Dish	Dish	Dish
Ventilation	Passive	Passive	Passive	Passive	Passive
Nominal burial depth (ft)	6	6	6	6	6
Declared inactive	1977	1980	1978	1977	1976
(Row Deleted)					
Interim stabilized	9/85	9/89	9/95	3/84	9/90

Note: Best-basis inventory AutoTCR documents (2-1-2005) from TWINS, Web Site - http://twinsweb.pnl.gov/twins.htm.
TWINS = Tank Waste Information Network System.

The SSTs were constructed in place with a carbon steel lining on the bottom and sides, and a reinforced concrete shell. The welded liners are independent of the reinforced concrete tanks and were designed to provide leak-tight containment of the liquid radioactive wastes and to protect the reinforced concrete from waste contact. All other loads (e.g., surface live loads, static and dynamic soil loads, dead loads, hydrostatic loads, and hydrodynamic loads) are carried by the reinforced concrete tank structure. The tanks have concave bottoms (center of tanks lower than the perimeter) and a curving intersection of the sides and bottom. Inlet and outlet lines are located near the top of the liners. These lines are also referred to as 'cascade' lines because they allowed transfer of fluids between tanks using gravity flow to support the transfer and storage of waste within a series of three 100-series SSTs.

Tanks C-101 through C-106 were modified after initial tank construction to add pits at the tank farm surface. Tanks C-107 through C-112 were also subsequently modified to add central saltwell pump pits. Because of these modifications, the configuration of tanks C-102 and C-104 is different than tanks C-107, C-108, and C-112 as described in the following sections.

2.2.1 Tanks C-102 and C-104 Configuration

The existing configurations of tanks C-102 and C-104 are similar as depicted in the cross-section view in Figure 2-3.

estimates developed using the Hanford Defined Waste (HDW) Model (RPP-19822, *Hanford Defined Waste Model – Revision 5.0).*

- The above meets the requirement in Section 2.1.3 of Appendix I of the HFFACO that requires those contaminants accounting for at least 95% of the impact to groundwater risk be addressed.

- The BBI is the best available data; however, the Part A Permit provides a list of constituents that may or may not be present in the SSTs. To address this uncertainty, a post-retrieval sample will be taken of the residual waste for all constituents identified in the Ecology-approved sampling and analysis plan, pursuant to the requirements of that sampling and analysis plan.

There are currently no plans to perform additional characterization (e.g., sampling and analyses) of the waste in tank C-102, C-104, C-107, C-108, or C-112 to support waste retrieval and transfer. Sampling and analyses of the waste from each of the tanks will be performed at or near the end of waste retrieval activities in support of component closure activity actions. Sampling and analysis activities associated with component closure actions will be defined through the planned component closure data quality objectives process and described in the associated waste sampling and analysis plans yet to be developed and to be approved by Ecology.

Meeting the informational requirements for waste transfers meets the substantive requirements of WAC 173-303-300, "General Waste Analysis." Compliance with the following documents is required before initiating a waste transfer:

1. HNF-SD-WM-EV-053, *Double-Shell Tank Waste Analysis Plan.* SST transfers into the DSTs for any reason must meet the waste acceptance criteria presented in this plan. This plan is written pursuant to WAC 173-303-300(5) and U.S. Environmental Protection Agency (EPA) guidance document OSWER 9938.4-03, *Waste Analysis at Facilities That Generate, Treat, Store and Dispose of Hazardous Waste.*

2. Waste Stream Profile Sheet (HNF-SD-WM-EV-053, Appendix A). The sheet addresses the applicable sections of WAC 173-303-300; 40 CFR 761, "Polychlorinated Biphenyls (PCBs). Manufacturing, Processing, Distribution, Commerce, and Use Prohibitions"; 40 CFR 268, "Land Disposal Restrictions"; and WAC 173-303-140, and also requires a waste compatibility assessment pursuant to HNF-SD-WM-DQO-001, *Data Quality Objectives for Tank Farms Waste Compatibility Program*, to meet WAC 173-303-395(1).

2.5.1 Tank C-102 Operating History

The following information is taken from HNF-SD-WM-ER-651, *Preliminary Tank Characterization Report for Single-Shell Tank 241-C-102: Best-Basis Inventory.* The purpose of HNF-SD-WM-ER-651 is to summarize the information on the historical uses, current status, and sampling and analysis results of waste stored in tank C-102.

Tank C-102 began receiving bismuth phosphate first-cycle decontamination (1C) waste from tank C-101 through the cascade line in 1946 and stored 1C waste until the second quarter of 1953. Tank C-102 cascaded waste into tank C-103 from 1946 until 1953. In 1953, the 1C waste in the tank was sluiced to a sludge heel in an effort to recover uranium. The tank received uranium recovery waste from the third quarter of 1953 until the fourth quarter of 1954. During the second quarter of 1957, the tank was scavenged.

During the third quarter of 1960, tank C-102 received waste water, and from the third quarter of 1960 until the fourth quarter of 1969, the tank received plutonium-uranium extraction (PUREX) cladding waste. The tank received waste from the 1966 thorium campaign during the second quarter of 1966 and PUREX organic wash waste from the second quarter of 1968 until the first quarter of 1969.

A maximum waste volume of approximately 530,000 gal. of waste in tank C-102 was reached in the first quarter of 1952 and remained at that level until the third quarter of 1952. The same amount of 530,000 gal. was reached in the first quarter of 1954 and remained at that level until the fourth quarter of 1956 (WHC-SD-WM-ER-313).

A saltwell pump was installed in tank C-102 in November 1975; saltwell pumping was completed in June 1978. The tank was declared inactive in 1977 and was partially isolated in December 1982. In November 1991, the tank was saltwell pumped again (GJ-HAN-86, *Vadose Zone Characterization Project at the Hanford Tank Farms Tank Summary Data Report for Tank C-102*).

2.5.2 Tank C-104 Operating History

The following information is taken from HNF-SD-WM-ER-679, *Tank Characterization Report for Single-Shell Tank 241-C-104*. The purpose of HNF-SD-WM-ER-679 is to summarize the information on the historical uses, current status, and sampling and analysis results of waste stored in tank C-104.

Tank C-104 went into service in 1946 when it began to receive 1C waste from B Plant (LA-UR-97-311, *Waste Status and Transaction Records Summary [WSTRS]*). The 1C waste began to cascade to tank C-105 in the first quarter of 1947. Waste additions continued until November 1947, when the tank and the cascade series were full. The tank remained full until 1953, when waste retrieval actions were initiated for uranium recovery. The tank was effectively emptied in early 1955. The tank remained empty until the fourth quarter of 1955 when it received tributyl phosphate (TBP) waste supernate and metal waste from tank C-112. Cladding waste was received from PUREX and was transferred to tanks C-101 and C-105 in 1956, and PUREX cladding waste was received again and cascaded to tank C-105 in 1957.

Tank C-104 received numerous transfers of different waste types. The tank currently contains only sludge consisting primarily of five waste types:

- Zirconium cladding waste (CWZr1)
- Organic wash waste (OWW3)

- Cladding waste (CWP2)
- Thorium waste (TH2)
- Cladding waste (CWP1).

From 1976 to 1980, tank C-104 exchanged supernate with tank A-102. Supernate was sent to tanks AZ-101 and AX-102 in 1978. The tank received supernate waste from tank C-103 in 1979. Tank C-104 was removed from service in 1980 and was declared interim stabilized in 1989.

2.5.3 Tank C-107 Operating History

The following information is taken from HNF-SD-WM-ER-474, *Tank Characterization Report for Single-Shell Tank 241-C-107*. The purpose of HNF-SD-WM-ER-474 is to summarize the information on the historical uses, current status, and sampling and analysis results of waste stored in tank C-107.

Tank C-107 was placed into service in 1946 when it began receiving 1C waste through diversion box 241-C-153. From the second quarter of 1946 until the third quarter of 1948, tank C-107 received 1C waste from the B and/or T Plants. In September 1947, tank C-107 was declared full and began cascading to tank C-108. Between 1947 and 1978, when it was declared inactive, numerous waste transfers were made into and out of tank C-107. Tank C-107 received 1C waste generated from the bismuth phosphate process, TBP (UR/TBP) liquid waste, PUREX cladding removal waste (CWP2), hot semiworks waste, waste from 244-CR (CR vault) and site laboratories, and strontium-rich sludge (SRR).

Two liquid-pumping campaigns have taken place since 1976. The tank was saltwell pumped from the third quarter of 1976 until the second quarter of 1977. Approximately 18,000 gal. were removed by jet pumping from November 1991 to January 1992 (HNF-SD-WM-ER-474).

The tank currently contains sludge consisting of three waste types: (1) 1C waste, (2) PUREX cladding removal waste, and (3) strontium-rich sludge. In general, 1C waste exhibits high concentrations of aluminum, bismuth, fluorine, iron, silicon, phosphate, and sulfate; PUREX cladding removal waste exhibits high concentrations of aluminum; and strontium-rich sludge exhibits high concentrations of sodium, iron, and strontium.

2.5.4 Tank C-108 Operating History

The following information is taken from WHC-SD-WM-ER-503, *Tank Characterization Report for Single-Shell Tank 241-C-108*. The purpose of WHC-SD-WM-ER-503 is to summarize the information on the historical uses, current status, and sampling and analysis results of waste stored in tank C-108.

Tank C-108 was placed into service in 1947 when it began receiving waste via the cascade line from tank C-107. Tank C-108 received 1C waste from the bismuth phosphate process, uranium recovery waste (UR) from the TBP process, in-farm ferrocyanide scavenging waste (TFeCN), and PUREX cladding waste (CWP). During the same period, supernate was transferred from tank C-108 to tanks BY-101 and BY-105. Other wastes received include Hot Semiworks Plant waste, PUREX organic wash waste, ion exchange waste, reduction oxidation waste, N Reactor waste, decontamination waste, and laboratory waste.

Between 1952 and 1976, when it was removed from service, numerous waste transfers were made into and out of tank C-108. The tank currently contains sludge consisting primarily of three waste types: (1) 1C waste, (2) TBP process waste, and (3) in-farm ferrocyanide scavenging waste. In general, 1C waste sludge exhibits high concentrations of aluminum, bismuth, fluorine, iron, silicon, phosphate, and sulfate; TBP sludge exhibits high concentrations of chromium, iron, sodium, phosphate, and sulfate; and in-farm ferrocyanide scavenging waste exhibits high concentrations of calcium, iron, nickel, phosphate, and cesium-137.

Saltwell pumping was completed in 1978, and intrusion prevention was completed on December 15, 1982 (WHC-SD-WM-TI-356, *Waste Storage Tank Status and Leak Detection Criteria*). The tank was designated as interim stabilized on March 9, 1984. This tank was added to the Ferrocyanide Watch List in January 1991 and was removed in June 1996.

2.5.5 Tank C-112 Operating History

The following information is taken from HNF-SD-WM-ER-541, *Tank Characterization Report for Single-Shell Tank 241-C-112*. The purpose of HNF-SD-WM-ER-541 is to summarize the information on the historical uses, current status, and sampling and analysis results of waste stored in tank C-112.

Tank C-112 was placed into service in 1946 when it began receiving 1C waste from the other two tanks in the cascade (tanks C-110 and C-111). The 1C waste originated from the bismuth phosphate separations process used at B Plant. Because tank C-112 is the final tank in a cascade series, most of the metal waste solids would have settled in the first two tanks. Supernate from tank C-112 was transferred to tank B-106 in 1952, leaving a 17,000-gal. heel in the tank. Tank C-112 was refilled with unscavenged uranium recovery waste in 1954. From late 1955 until 1958, the tank was used for settling scavenged ferrocyanide waste.

Between 1961 and 1976, when it was removed from service, numerous waste transfers were made into and out of tank C-112. The tank was saltwell pumped in 1983, resulting in the transfer of 5,000 gal. of waste from tank C-112 to DST 241-AN-103 (HNF-SD-WM-ER-541).

The tank currently contains sludge consisting primarily of three waste types: (1) 1C waste, (2) in-farm ferrocyanide scavenging waste, and (3) cladding waste (CWP1). In general, 1C waste sludge exhibits high concentrations of aluminum, bismuth, fluorine, iron, silicon, phosphate, and sulfate; in-farm ferrocyanide scavenging waste exhibits high concentrations of calcium, iron, nickel, phosphate, and cesium-137; and cladding waste (CWP1) exhibits high concentrations of aluminum.

2.6 TANK ANCILLARY EQUIPMENT

There is a complex waste transfer system of pipelines (transfer lines), diversion boxes, vaults, valve pits, and other miscellaneous structures that are collectively referred to as ancillary equipment. The routing of liquid waste to and from the tanks was accomplished using this transfer system. The diversion boxes provide the means for routing waste from one transfer line to another via jumper assemblies. The diversion boxes are belowground, reinforced concrete boxes that were designed to contain any waste that leaked from the waste transfer line connections and route it to a collection tank.

One valve pit, 241-C (a corrugated structure with a concrete floor), also served the C tank farm and is located southwest of tank C-103. This pit was installed as part of the saltwell pumping program to allow multiple saltwells to pump to the 244-CR vault receiver tank, 003, through a single transfer line, SN-275.

Table 2-5 provides a summary of the C tank farm ancillary equipment connected to tanks C-102, C-104, C-107, C-108, and C-112.

The existing buried waste transfer lines routed to tanks C-102, C-104, C-107, C-108, and C-112 have been isolated to prevent the inadvertent transfer of waste or intrusion of water into the tanks following retrieval with the exception of the cascade lines and saltwell transfer lines. With these isolation measures in place, the process lines are in a stable configuration and do not represent pathways for water or additional waste to enter the tanks.

Various monitoring instruments will be used to collect data to support operation of the WRS and perform environmental monitoring. Cameras will be installed in each of the SSTs to provide the capability to visually monitor and aid in control of waste retrieval operations. Instrumentation will also be provided to monitor process control data (e.g., pressures and flow rates). This information will be used to support material balance calculations. The existing ENRAF[1] level gauges will be retracted during waste retrieval operations and will be used periodically to monitor waste levels.

Before initiating waste retrieval, a formal waste compatibility assessment will be performed in accordance with HNF-SD-WM-OCD-015, *Tank Farm Waste Transfer Compatibility Program*. Formal issuance of the compatibility assessment will not be completed until just before waste retrieval operations begin to ensure that current conditions are captured in the assessment.

During waste retrieval operations, the tank(s) will be actively ventilated. The ventilation system will consist of skid-mounted high-efficiency particulate air filtered portable exhausters. The ventilation system will be designed to pass air through the tank, thereby reducing condensation and fog within the tank. The vent systems will typically include a heater, prefilter, demister, two high-efficiency particulate air filters and test sections, exhaust fan, and stack. Project plans include the design and installation of a new ventilation system to support waste retrieval operations for the C farm tanks as shown in Figure 3-2. Details of the new ventilation system are provided in AIR 05-407, *Categorical Tank Farm Facility Waste Retrieval and Closure: Phase II Waste Retrieval Operations*, and DE05NWP-002, *Notice of Construction (NOC) Application for Operations of Waste Retrieval Systems in the Single-Shell Tank (SST) Farms*.

ORP and CH2M HILL Hanford Group, Inc. (CH2M HILL), pursuant to federal requirements for protection of their workers, will develop and implement a personal exposure sampling and monitoring plan for SST waste retrievals. This plan will be developed and implemented by the operations Industrial Hygiene (IH) departments per the CH2M HILL Environmental Health Program with consideration of input from Ecology. Subsequent to issuance of the IH sampling and monitoring plan, changes to that portion of the plan pertaining to sampling exhauster emissions at the stack will be provided to Ecology for Ecology's information in as timely a manner as possible.

New equipment will be installed in the tanks to support waste retrieval. Existing equipment will be removed if and as required to make room for the new equipment. The new slurry pump will be installed in the center riser located in the center pit. Each pump may be mounted on a winch system that will allow the pump to be lowered as waste retrieval progresses. The pump suction will be installed just under the waste surface to start, so little or no water should be required for installation due to the sludge nature (i.e., not hard saltcake) of the waste and the small submergence of the pump suction. The system will be designed to allow the pump suction to be lowered as low as possible in each tank to facilitate maximum waste removal. This will allow approximately 10 ft of height adjustment.

[1] ENRAF is a trademark of Enraf, Inc., Enraf B.V., Delft, The Netherlands.

3.1.2 Double-Shell Receiver Tanks

The supernate pump and slurry distributor installed in DST AN-106 in support of tank C-103 waste retrieval (RPP-21895) may continue to be used to pump supernate back to the C farm and distribute the sludge as received from tanks C-107, C-108, and C-112. The pump installed in DST AN-101 under Project W-211 may be used to pump supernate in support of C farm retrieval. A new slurry distributor will be installed in DST AN-101 to distribute the sludge received from C farm tanks. A new supernate pump and a new slurry distributor are planned for DST AY-101 to support waste retrieval from C farm tanks.

Because the elevation of the AN farm is approximately 22 ft higher than the C farm and the elevation of the AY tank farm is approximately 32 ft higher than the C farm, the slurry distributor and the supernate pump incorporate anti-siphon devices to prevent unintentional flow from the DST to the SST. Condensate drain lines from the ventilation system will be routed to the last sound tank in C tank farm scheduled for waste retrieval.

All waste transfers, including transfer of waste from the C farm tanks to the DSTs and the transfer of supernate from DSTs back to C farm tanks, will be performed using transfer lines that provide secondary containment. The waste retrieval project currently plans to use overground hose-in-hose transfer lines (HIHTLs) and the *Resource Conservation and Recovery Act of 1976* (RCRA)-compliant DST transfer system.

3.1.3 Waste Retrieval System Operating Description

The overall WRS operating strategy will consist of reducing the SST waste inventories. The process will be monitored using closed-circuit television to facilitate waste retrieval and minimize any liquids in the tanks. Supernate will be used as the primary retrieval liquid. Raw water will be used in limited quantities as necessary for waste conveyance and transfer line flushing.

During routine operations, waste retrieval will be initiated by starting the supernate pump in the DST source tank and using the pumped supernate to provide sluicing fluid to the selected sluice nozzle. Initial sluicing will be focused in the center portion of the tank to minimize the time required to get liquid to the slurry pump to allow it to be started. The in-tank camera will be used to provide visual input for directing the sluice nozzle. The slurry pump in tank C-102, C-104, C-107, C-108, or C-112 will be started as soon as liquid from the sluicer operation reaches the area of the pump inlet and there is enough liquid present to prime and operate the pump. During waste retrieval, the flow of liquid into the tanks through the sluice nozzles will be controlled to both limit accumulation of liquid in the tank and to maximize waste retrieval efficiency. The slurry removed will consist of both mobilized tank waste and DST supernate used for mobilization. Maintaining a balanced pumping rate into and out of the tanks is integral to minimizing the liquid volume in the tanks and reducing the potential for leakage.

If initial sluicing efforts show that tank C-102, C-104, C-107, C-108, or C-112 sludge is not readily mobilized, it may be necessary to add sufficient liquid to the tank(s) to cover the sludge and allow it to sit for a period of time to soften the solid waste before sluicing is resumed. It is

3.7 ANTICIPATED IMPACTS OF TANK WASTE RETRIEVAL ON FUTURE PIPELINE/ANCILLARY EQUIPMENT RETRIEVAL

The existing buried waste transfer lines routed to tanks C-102, C-104, C-107, C-108, and C-112 have been isolated to prevent the inadvertent transfer of waste or intrusion of water into the tanks. Following waste retrieval activities for these tanks, the new transfer lines and auxiliary equipment will be flushed as needed and the equipment reused or disposed of as discussed in Section 3.9.

Any line flushes for the new transfer lines should direct the flush solution to the receiver DSTs. However, because of the physical location of C tank farm at a lower elevation than the DSTs, there will be some line drainback. The holdup for each transfer line is in the 150- to 200-gal. range. This solution would go to the tank just retrieved, unless a valve change could be made to direct the solution to another SST covered by this tank waste retrieval work plan which had not yet completed retrieval.

Flushing of any valve boxes should not be necessary following retrieval since any such flushing, which is expected to be transferred back to the SST being retrieved, would be expected to be performed before completion of retrieval. Should the situation arise where a valve box needs to be flushed following retrieval, it is estimated that the flush volume would be in the 100- to 200-gal. range. This solution would go to the tank just retrieved, unless a valve change could be made to direct the solution to another SST covered by this tank waste retrieval work plan which had not yet completed retrieval.

When retrieval activities are completed, the exhauster(s) used will be disconnected for use elsewhere. This will require draining the exhauster seal pot back to the receiver tank for the drain line. Such drainage will be in the 0- to 20-gal. range.

It is currently planned to leave all in-tank equipment (e.g., the transfer pump) in the tank following retrieval. However, in the unlikely event it is necessary to remove such equipment, it may have to be washed down upon removal to remove excess contamination or to reduce exposure for personnel protection. The volume of water expected for such purposes would likely be in the 50- to 200-gal. range.

Existing risers, pits, and/or caissons associated with the tanks will be isolated following the retrieval activities. These isolation methods are designed to minimize water intrusion to the tank.

In accordance with RPP-13774, disposition of the ex-tank ancillary equipment, including pipelines, will be performed in accordance with a separate component closure activity plan. Flushing of old lines or pits would not be done unless required or permitted by the component closure activity plan. Should such flushing be required or necessary, it would not take place until closure activities were underway, so the impact of any line flush volumes would be accounted for in the closure plan approved tank fill process. See Section 7.1.3.2 for assumptions regarding characterization of residual waste in piping system components.

Tank C-107 is monitored for leak detection on a weekly basis using an ENRAF level gauge (OSD-T-151-00031). Although tank C-107 is classified as interim stabilized, leak detection monitoring is performed because the flow rate at the end of interim stabilization exceeded 0.05 gal/min and the configuration of the tank makes leak detection monitoring technically feasible. The basis for in-tank leak detection and intrusion monitoring is provided in RPP-9937, *Single-Shell Tank System Leak Detection and Monitoring Functions and Requirements Document*.

The waste level in the receiver DSTs is monitored using an ENRAF level gauge for primary level monitoring as described in OSD-T-151-00031, Section 4.0. Additionally, three annulus leak detector probes provide indication of tank leaks as described in OSD-T-151-00031, Section 4.0.

4.2 LEAK DETECTION AND MONITORING SYSTEM

This section provides a description of the leak detection and monitoring (LDM) system that will be deployed at tanks C-102, C-104, C-107, C-108, and C-112 during waste retrieval along with a description of how it will be operated.

4.2.1 Leak Detection and Monitoring for Single-Shell Tanks

The primary method for leak detection and leak monitoring for tanks C-102, C-104, C-107, C-108, and C-112 involves periodic gamma and neutron moisture surveys of the drywells surrounding the tanks. Established drywell logging methods will be used as the primary method of leak detection.

HRR will be deployed on tanks C-102, C-104, C-107, C-108, and C-112 pursuant to the requirements of HFFACO Appendix I, as determined by the results of the HRR deployment demonstration at tank S-102.

Although HRR will not be used for process control, Ecology will be informed if an anomaly, indicating a potential leak, is detected. If, after three months, the status of the anomaly has not been confirmed, Ecology will be consulted as to possible changes in groundwater and analyte monitoring frequency. In-tank process control parameters will be used to supplement the ex-tank methods and provide secondary leak detection. The following sections summarize these methods.

The overall strategy for leak detection during waste retrieval at tanks C-102, C-104, C-107, C-108, and C-112 is to deploy best available technologies for leak detection and leak monitoring. The HRR LDM system has not been proven on an SST at this time. HRR leak detection has been deployed in a demonstration mode on tank S-102. A leak injection test will be performed using an S-102 drywell to establish how well the HRR system performs in terms of detecting leaks and in estimating leak volumes and leak rates. This test is described in RPP-17191, *SST Deployment Demonstration and Injection Leak Testing of the HRR Long Electrode LDM System*.

These first deployments of the HRR system (tank S-102 and the next two 100-series SSTs to be retrieved) and the leak injection test are needed to validate and verify this method before it can be used as a baseline LDM method. During the HRR demonstration deployment the existing drywells surrounding the tanks will be monitored as the primary leak detection method and mass balance calculations will be performed as a backup. The HRR demonstration deployment will provide valuable operating experience and will be used for data collection and evaluation. HRR will only be used in a demonstration mode on a tank during waste retrieval until a decision is made on whether or not it will be used as a baseline leak detection system during retrieval. Should HRR be validated before completion of waste retrieval, HRR will, at that time, become the primary leak detection system for these tanks and drywell monitoring will be stopped for the retrieval LDM where HRR is the primary LDM system.

Additional detail on the SST leak detection approach is provided in the following sections. Leak detection in the waste transfer system and in the respective receiver DSTs will be performed using standard leak detection methods in the transfer pits and DST annulus.

The results from drywell monitoring, as well as a summary and analysis of this monitoring, including tools used, calibration, boreholes logged, depth of logging, frequency, logging rate, and data analysis will be submitted to Ecology within the retrieval data report per Appendix I of the HFFACO.

4.2.1.1. Ex-Tank Leak Detection for Single-Shell Tanks. The existing logging systems or the new monitoring system described below will be used along with manually deployed moisture gauges and gross gamma detectors to monitor soil conditions surrounding the tanks for increases in gamma activity and/or moisture content that may be evidence of tank leakage. The logging systems will be deployed by qualified personnel in accordance with the applicable procedures before waste retrieval operations begin by deploying calibrated gamma and neutron moisture probes over the full depth of each drywell. The pre-retrieval logging results will provide a baseline for selection of specific regions of interest (as well as the region near the base of the tanks). Weekly logging will be performed during waste retrieval operations. Due to operational constraints, this weekly reading may be missed occasionally. Ecology will be informed of missed drywell monitoring. The drywells will be rebaselined within six months after retrieval operations have been completed and will be monitored quarterly for a year to ensure that no new contaminant plumes have developed as a result of the retrieval activity, and that any existing plumes have not been exacerbated.

During waste retrieval, the handheld moisture gauge will be deployed to monitor specific regions of interest in selected drywells for increases in soil moisture content. The handheld moisture gauge will be deployed by qualified personnel in accordance with TO-320-022, *Operate Model 503DR Hydroprobe Neutron Moisture Detection*. The neutron moisture probe is used to monitor the moisture (e.g., water) content in the sediments around the drywells. Manually deployed moisture gauges will be used to monitor the drywells at specific regions of interest, including the interval at the base of the tank that is 35 to 50 ft below grade and any layers with fine sediments. The base of the tank farm excavation represents a zone of material compacted by tank farm construction activity that may affect lateral movement of water in the vadose zone.
Likewise, any fine sediment layers would be expected to control accumulation of any moisture

associated with a new leak plume. In the event of an unexplained increase in soil moisture content, additional monitoring with the truck-mounted systems will be used if truck access is practical to determine if there have been any changes in gamma-emitting radionuclide concentration surrounding the drywells.

A new readily transportable drywell logging system capable of concurrent gamma and moisture measurement is being acquired for use in support of waste retrieval operations in the tank farms. The retrieval monitoring system (RMS) will have calibrated neutron moisture and gross (total) gamma detectors on a combined probe. It will provide dual data logs over preselected depth intervals in the drywells. The overall size and portability of the RMS will minimize interference with surface activity, and the capability of collecting both moisture and gamma data in a single log run will result in a significant reduction in the cost of monitoring activities. The new logging system also provides for electronic data recording. When approved for use, the new drywell logging system will be substituted for the handheld moisture gauge and may also be used in place of truck-mounted logging systems. Drywells with very high gamma activity, such as 30-05-07, may still require the use of the high rate logging system, but it is likely that a high rate detector can be developed for the RMS.

Current plans include monitoring of the following drywells:

- **Tank C-102** – 30-03-07, 30-00-03, 30-01-01, 30-05-05, and 30-05-04
- **Tank C-104** – 30-04-01, 30-04-02, 30-04-03, 30-05-06, 30-04-04, 30-04-05, 30-04-08, and 30-04-12
- **Tank C-107** – 30-07-01, 30-07-02, 30-07-05, 30-07-07, 30-07-08, 30-07-10, and 30-07-11
- **Tank C-108** – 30-08-02, 30-08-03, 30-05-10, 30-07-02, 30-07-01, 30-11-05, and 30-08-12
- **Tank C-112** – 30-12-13, 30-12-01, 30-12-03, 30-09-10, 30-09-11, 30-11-01, and 30-12-09.

There is a potential that access to some drywells may be precluded by the placement of equipment, shielding, ALARA (as low as reasonably achievable) concerns, or alterations to the tank farm surface as a part of ongoing waste retrieval activities. Any resulting changes to LDM activities described in this tank waste retrieval work plan will be approved by Ecology within 24 hours through the Change Notice form.

The following background information describes the suite of drywell logging tools, what they measure, and general measurement capabilities that can be used to monitor conditions around the drywells. Details of the drywell monitoring activities, including identification of logging tools and target logging intervals, will be defined in the process control plan or specific procedures.

The spectral gamma logging system is used to establish baseline conditions from 1995 to 2000. This logging system is based on a liquid nitrogen cooled high purity germanium (HPGe) detector, which provides excellent gamma energy resolution for identification and quantification of individual radionuclides from background levels (method detection limit about 0.1 pCi/g cesium-137 under typical conditions) up to about 10,000 pCi/g cesium-137. A high rate detector with internal and external shields is available to extend the measurement range to about 10^9 pCi/g cesium-137. The spectral gamma logging system truck is also used to operate the neutron moisture logging system, which measures in situ vadose zone moisture over the range of 0 to about 25 vol% moisture content. The neutron moisture logging system uses the same source-detector relationship as the handheld moisture gauge.

The radionuclide assessment system was specifically designed for routine monitoring against the baseline established from the spectral gamma logging system data. The radionuclide assessment system uses a series of three interchangeable NaI(Tl)-based scintillation detectors for measurement over the range from background levels to about 10^5 pCi/g cesium-137. The radionuclide assessment system records counts in specific energy ranges as well as total gamma activity. Although it does not have the energy resolution capability of the spectral gamma logging system, it is mounted on a smaller truck and collects data at a faster rate.

The handheld moisture gauge is a commercially available system (model 503DR Hydroprobe manufactured by CPN International, Inc.) designed for manual measurement of in situ moisture content at one or more points in the subsurface. Use of the handheld moisture gauge does not require truck access into the tank farm and is more practical for frequent use during waste retrieval.

The RMS is a modular, portable logging unit capable of concurrent measurement of gross gamma activity and neutron moisture content. It is based on a commercially available logging system. The source-detector arrangement for neutron moisture measurement has been modified to provide data comparable to that currently obtained from the handheld moisture gauges and the neutron moisture logging system. DOE is in the process of acquiring the RMS and current planning is for the system to be available for use in 2005. It is anticipated that the RMS will have a measurement range from background up to 100,000 pCi/g cesium-137 and 0 to 25 vol% moisture content.

4.2.1.2. In-Tank Volume (Material) Balance (During Operation). Material balances will be performed for all transfers between tanks in accordance with the process control plan. Primary inputs to the material balance include water additions; volume of waste transferred from tank C-102, C-104, C-107, C-108, or C-112; volume of supernate transferred from the respective receiver tank to tank C-102, C-104, C-107, C-108, or C-112; and the volume of waste within the respective receiver tank. The accuracy of the material balance will be limited because waste volume data for the tank from which waste is being retrieved can only be estimated. Given the operational strategy to minimize liquids in tank C-102, C-104, C-107, C-108, or C-112 during waste retrieval operations, there will not be a liquid level measurement available. Given the dished bottoms of the tanks and the location of the level instrumentation near the side, waste levels cannot be measured below approximately 12,000 gal. In the absence of a means to collect real-time volume measurements for the tank, estimates will be developed using the in-tank camera combined with material balance data.

A simplified flowsheet showing measurement locations is provided in Figure 4-3. The material balance can be used to identify large discrepancies in the waste retrieval process but will not be able to identify smaller leaks. Therefore, material balance calculations will only be used as a backup leak detection method.

4.2.1.3. High-Resolution Resistivity. The HRR LDM system is currently being tested at tank S-102. Until completion of the testing, HRR will be deployed at tanks C-102, C-104, C-107, C-108, and C-112 in a demonstration mode, as retrieval of these tanks occurs during HRR testing at tank S-102. If the testing at tank S-102 demonstrates HRR is not a suitable LDM system for retrievals in a tank farm environment, its continued deployment will be halted. If the testing demonstrates HRR is a suitable LDM system for retrievals in a tank farm environment, HRR will be deployed as the LDM system for each of the tanks addressed in this TWRWP remaining to be retrieved following completion of the tests at tank S-102.

The HRR method uses baseline geophysical resistivity measurements as a means to detect changes in baseline moisture levels. The electrical resistivity of the sediments beneath a waste tank depends on a number of parameters, one of which is moisture content. The leakage of water or tank waste into these sediments lowers the sediment resistivity. The HRR method detects a leak by comparing a current resistivity measurement against a previously obtained baseline measurement, or a 'pre-leak' measurement. This delta processing allows the HRR method to discount existing resistivity differences in the soil caused by factors that include conductive structures or prior leaks. Changes in soil moisture from precipitation will need to be taken into consideration during monitoring to reduce the potential for making an incorrect leak determination.

A probable limitation to the HRR system is that it will largely provide data as a two-dimensional diagram from the viewpoint of looking down on the tank. As deployed with the long-length electrodes (drywell pipes), the system will likely only permit an evaluation of data in a two-dimensional view.

The basic resistivity measurement concept utilizes the existing drywells as measurement electrodes. By applying power to each electrode pair and making resistivity measurements from all other electrode pairs, an 'image' of the sediment resistivity can be obtained. The planned deployment of the high-resolution resistivity (HRR) system at tank C-102 uses the existing drywells around the tank and four or five non-powered surface electrodes around the southeastern portion of the tank where there are no existing drywells. Surface electrodes are being tested at tank S-102 before their use on tank C-102.

HRR data will be evaluated on a periodic basis as described in RPP-24576, *HRR LDM Data Processing, Assessment, and Reporting Procedure for C-Farm*. RPP-24576 provides the details as to how the data are reviewed and on what frequency. Following is a summary of some of the information provided in this document. This summary is for information purposes only, and where a difference exists between RPP-24576 and this summary, the wording in RPP-24576 takes precedence.

The resistivity data will be analyzed for the presence of large signal changes that are indicative of leaks having a low false alarm potential. This will be a subjective evaluation wherein the trace lines are observed; if no changes are evident, it is assumed that there is no leak discernable with HRR. If significant anomalies are observed, these will be statistically evaluated against 95% confidence intervals for a shift in the baseline mean data. Ecology will be informed if an anomaly indicating a potential leak is detected during waste retrieval.

Deployment of the HRR system for leak detection in the tank farms is new. It is expected that there will be lessons learned during the demonstration deployments. Lessons learned from the demonstration deployments of the HRR system will be incorporated to the extent possible in the design and operation of subsequent HRR system deployments.

4.2.2 Leak Detection in Transfer Lines and Pits

Supernate will be transferred from the respective receiver DST and liquid waste and slurries will be transferred from tanks C-102, C-104, C-107, C-108, and C-112 back to their respective receiver DST using temporary hose-in-hose overground transfer lines and pits. Leak detectors located in pits and pump pits will be monitored during waste transfers. Leaks are also detected by monitoring flows and by radiation monitoring of the HIHTL in accordance with the requirements of RPP-13033, *Tank Farms Documented Safety Analysis*, and RPP-12711. Pits associated with the receiver tank will also be monitored.

Leakage from the primary overground transfer hose (inner hose) will be contained by the secondary confinement system (outer hose). The secondary confinement system has been designed to drain any fluid released from the primary hose to a common point for collection, detection, and removal. Leak detection elements are installed in pits at the ends of the transfer lines. If a leak occurs, the liquid will contact the detector, which will actuate an alarm and shutdown the transfer pumps either automatically or manually.

4.2.3 Leak Detection in the Receiver Double-Shell Tank

The existing leak detection systems in the receiver DSTs will be used as required in OSD-T-151-00031. A leak from the primary vessel of the receiver DST will be detected by a conductivity probe installed in the annulus.

4.3 RATIONALE FOR SELECTION OF LEAK DETECTION AND MONITORING TECHNOLOGY

The LDM technology selected for deployment at tanks C-102, C-104, C-107, C-108, and C-112 represents the best available technology that is consistent with the planned approach for waste retrieval. The primary leak detection method uses available drywells and established technologies to monitor for liquid losses in the soils surrounding the tanks. Additionally, mass balance will be used as a backup to the primary method. The HRR system, as described in

Section 4.2.1.3 will be deployed as a demonstration technology that may provide improved leak detection monitoring.

4.4 LEAK DETECTION FUNCTIONS AND REQUIREMENTS

This section defines the upper-level functions and corresponding requirements to which the leak detection systems for tanks C-102, C-104, C-107, C-108, and C-112 must be designed and operated. The system specification for the C farm 100-series tanks that defines design criteria will be consistent with this work plan. The functions and requirements for LDM are detailed in Table 4-1.

4.5 ANTICIPATED TECHNOLOGY PERFORMANCE

There is no single value that can be stated as the maximum leak that could go undetected by drywell monitoring for tank C-102, C-104, C-107, C-108, or C-112. There are a wide range of variables that influence the effectiveness of drywell monitoring. A Monte Carlo-type analysis of drywell monitoring performance for SST leak detection was prepared that considered the impact of all significant variables (RPP-10413, *Tank S-112 Saltcake Waste Retrieval Demonstration Project Leak Detection, Monitoring, and Mitigation Strategy*, Appendix B). The calculations indicated that, assuming an optimum 10-ft distance between the tank leak location and the drywell, the 95th percentile leak size is 300 gal. This means if the leak is 10 ft from the drywell, 95% of the calculated leak volumes at detection are 300 gal. or less. When the leak to drywell spacing is set at 45 ft, the 95th percentile leak volume size is 18,000 gal. When it is assumed that there are three drywells around the tank and the leak to drywell distance is varied randomly for the analysis, the 95th percentile leak size is 7,980 gal. The variation between the low and high end of the 300- to 18,000-gal. range illustrates the impact of the variables which include, but are not limited to, the distance between leak location and the drywell, leak rate, monitoring equipment capabilities, soil properties, and soil moisture content. Many additional factors can influence the leak rate. The selected monitoring frequency can also impact the leak size at discovery.

hypothetical volume used only as a point of reference and for consistency with previous analyses. It was not intended to represent anticipated retrieval leak volumes or leak detection limits for tank C-102.

The planning for tanks C-102, C-104, C-107, C-108, and C-112 waste retrieval as of mid March 2005 is given in Section 3.1.1. RPP-21753, *C-Farm 100 Series Tanks, Retrieval Process Flowsheet Description*, provides an estimated flowsheet for the C tank farm waste retrieval process based upon this planning. However, there are numerous possible combinations of which single-shell tanks can go to which double-shell tanks (DSTs) and in which order. These combinations are further complicated with the retrieval of other C farm tanks not included in this tank waste retrieval work plan. It is impractical to provide flowsheets and preliminary risk evaluations that look at all possible combinations of tanks and tank retrieval order when the end result is not expected to cause any significant change in the risk associated with the overall waste retrieval process. Therefore, the dotted lines in Figures A-1, A-2, and A-3 provide the calculated risk impacts for an 8,000-gal. retrieval leak based upon the retrieval plan in Section 3.1.1, and an assumed worst case 8,000-gal. retrieval leak.

The base case 8,000-gal. leak uses concentrations obtained from RPP-21753, with the sluicing supernate coming from the DSTs specified in Section 3.1.1. The assumed worst case 8,000-gal. leak for technetium-99 is based upon sluicing with a technetium-99 concentration of 8.3×10^{-5} Ci/L. The assumed worst case 8,000-gal. leak for chromium is based upon sluicing with a chromium concentration of 2.3 g/L. The assumed worst case 8,000-gal. leak for nitrite is based upon sluicing with a nitrite concentration of 43 g/L.

The worst case technetium-99 concentration assumes sluicing with tank AY-101 supernate following waste retrieval from tank C-112. The worst case chromium concentration assumes sluicing with tank AY-101 supernate only (the tank AY-101 supernate chromium concentration is sufficiently high that the supernate chromium concentration will be reduced as single-shell tank waste retrieval proceeds). The worst case nitrite concentration assumes sluicing with tank AY-101 supernate following waste retrieval from tanks C-104 and C-107. The worst case concentrations are estimates only and can vary with the amount of raw water added during waste retrieval or a number of other factors. The worst case concentrations are not based upon any planned waste retrieval sequence, they just represent more restrictive mixes of the five single-shell tanks with a receiver DST for the tanks discussed in this tank waste retrieval work plan.

Should the retrieval plan vary from that in Section 3.1.1, the Washington State Department of Ecology will be notified of the change via a change notice form, per Section 9.3 of the HFFACO Action Plan. A retrieval plan variation means: (1) altering the designated DST receiver tank for a given single-shell tank, or (2) making transfers from DSTs other than those listed in Section 3.1.1 into one of the Section 3.1.1 receiver DSTs, which will result in key indicator contaminant concentrations in the receiver DST liquid phase greater than those specified in RPP-21753 for the starting DST supernate concentration. A statement will be included on the change notice form that the estimated risk associated with the revised waste retrieval plan is bounded by the assumed worst case impact shown in Figures A-1, A-2, and A-3. Alternatively, if the 8,000-gal. retrieval leak risk for a revised retrieval plan may not be bounded by the assumed worst case impact shown in Figures A-1, A-2, and A-3, revised risk impacts will be provided.

hypothetical volume used only as a point of reference and for consistency with previous analyses. It was not intended to represent anticipated retrieval leak volumes or leak detection limits for tank C-104.

The planning for tanks C-102, C-104, C-107, C-108, and C-112 waste retrieval as of mid March 2005 is given in Section 3.1.1. RPP-21753, *C-Farm 100 Series Tanks, Retrieval Process Flowsheet Description*, provides an estimated flowsheet for the C tank farm waste retrieval process based upon this planning. However, there are numerous possible combinations of which single-shell tanks can go to which double-shell tanks (DSTs) and in which order. These combinations are further complicated with the retrieval of other C farm tanks not included in this tank waste retrieval work plan. It is impractical to provide flowsheets and preliminary risk evaluations that look at all possible combinations of tanks and tank retrieval order when the end result is not expected to cause any significant change in the risk associated with the overall waste retrieval process. Therefore, the dotted lines in Figures B-1, B-2, and B-3 provide the calculated risk impacts for an 8,000-gal. retrieval leak based upon the retrieval plan in Section 3.1.1, and an assumed worst case 8,000-gal. retrieval leak.

The base case 8,000-gal. leak uses concentrations obtained from RPP-21753, with the sluicing supernate coming from the DSTs specified in Section 3.1.1. The assumed worst case 8,000-gal. leak for technetium-99 is based upon sluicing with a technetium-99 concentration of 8.3×10^{-5} Ci/L. The assumed worst case 8,000-gal. leak for chromium is based upon sluicing with a chromium concentration of 2.3 g/L. The assumed worst case 8,000-gal. leak for nitrite is based upon sluicing with a nitrite concentration of 43 g/L.

The worst case technetium-99 concentration assumes sluicing with tank AY-101 supernate following waste retrieval from tank C-112. The worst case chromium concentration assumes sluicing with tank AY-101 supernate only (the tank AY-101 supernate chromium concentration is sufficiently high that the supernate chromium concentration will be reduced as single-shell tank waste retrieval proceeds). The worst case nitrite concentration assumes sluicing with tank AY-101 supernate following waste retrieval from tanks C-104 and C-107. The worst case concentrations are estimates only and can vary with the amount of raw water added during waste retrieval or a number of other factors. The worst case concentrations are not based upon any planned waste retrieval sequence, they just represent more restrictive mixes of the five single-shell tanks with a receiver DST for the tanks discussed in this tank waste retrieval work plan.

Should the retrieval plan vary from that in Section 3.1.1, the Washington State Department of Ecology will be notified of the change via a change notice form, per Section 9.3 of the HFFACO Action Plan. A retrieval plan variation means: (1) altering the designated DST receiver tank for a given single-shell tank, or (2) making transfers from DSTs other than those listed in Section 3.1.1 into one of the Section 3.1.1 receiver DSTs, which will result in key indicator contaminant concentrations in the receiver DST liquid phase greater than those specified in RPP-21753 for the starting DST supernate concentration. A statement will be included on the change notice form that the estimated risk associated with the revised waste retrieval plan is bounded by the assumed worst case impact shown in Figures B-1, B-2, and B-3. Alternatively, if the 8,000-gal. retrieval leak risk for a revised retrieval plan may not be bounded by the assumed worst case impact shown in Figures B-1, B-2, and B-3, revised risk impacts will be provided.

hypothetical volume used only as a point of reference and for consistency with previous analyses. It was not intended to represent anticipated retrieval leak volumes or leak detection limits for tank C-107.

The planning for tanks C-102, C-104, C-107, C-108, and C-112 waste retrieval as of mid March 2005 is given in Section 3.1.1. RPP-21753, *C-Farm 100 Series Tanks, Retrieval Process Flowsheet Description*, provides an estimated flowsheet for the C tank farm waste retrieval process based upon this planning. However, there are numerous possible combinations of which single-shell tanks can go to which double-shell tanks (DSTs) and in which order. These combinations are further complicated with the retrieval of other C farm tanks not included in this tank waste retrieval work plan. It is impractical to provide flowsheets and preliminary risk evaluations that look at all possible combinations of tanks and tank retrieval order when the end result is not expected to cause any significant change in the risk associated with the overall waste retrieval process. Therefore, the dotted lines in Figures C-1, C-2, and C-3 provide the calculated risk impacts for an 8,000-gal. retrieval leak based upon the retrieval plan in Section 3.1.1, and an assumed worst case 8,000-gal. retrieval leak.

The base case 8,000-gal. leak uses concentrations obtained from RPP-21753, with the sluicing supernate coming from the DSTs specified in Section 3.1.1. The assumed worst case 8,000-gal. leak for technetium-99 is based upon sluicing with a technetium-99 concentration of 8.3×10^{-5} Ci/L. The assumed worst case 8,000-gal. leak for chromium is based upon sluicing with a chromium concentration of 2.3 g/L. The assumed worst case 8,000-gal. leak for nitrite is based upon sluicing with a nitrite concentration of 43 g/L.

The worst case technetium-99 concentration assumes sluicing with tank AY-101 supernate following waste retrieval from tank C-112. The worst case chromium concentration assumes sluicing with tank AY-101 supernate only (the tank AY-101 supernate chromium concentration is sufficiently high that the supernate chromium concentration will be reduced as single-shell tank waste retrieval proceeds). The worst case nitrite concentration assumes sluicing with tank AY-101 supernate following waste retrieval from tanks C-104 and C-107. The worst case concentrations are estimates only and can vary with the amount of raw water added during waste retrieval or a number of other factors. The worst case concentrations are not based upon any planned waste retrieval sequence, they just represent more restrictive mixes of the five single-shell tanks with a receiver DST for the tanks discussed in this tank waste retrieval work plan.

Should the retrieval plan vary from that in Section 3.1.1, the Washington State Department of Ecology will be notified of the change via a change notice form, per Section 9.3 of the HFFACO Action Plan. A retrieval plan variation means: (1) altering the designated DST receiver tank for a given single-shell tank, or (2) making transfers from DSTs other than those listed in Section 3.1.1 into one of the Section 3.1.1 receiver DSTs, which will result in key indicator contaminant concentrations in the receiver DST liquid phase greater than those specified in RPP-21753 for the starting DST supernate concentration. A statement will be included on the change notice form that the estimated risk associated with the revised waste retrieval plan is bounded by the assumed worst case impact shown in Figures C-1, C-2, and C-3. Alternatively, if the 8,000-gal. retrieval leak risk for a revised retrieval plan may not be bounded by the assumed worst case impact shown in Figures C-1, C-2, and C-3, revised risk impacts will be provided.

hypothetical volume used only as a point of reference and for consistency with previous analyses. It was not intended to represent anticipated retrieval leak volumes or leak detection limits for tank C-108.

The planning for tanks C-102, C-104, C-107, C-108, and C-112 waste retrieval as of mid March 2005 is given in Section 3.1.1. RPP-21753, *C Farm 100-Series Tanks, Retrieval Process Flowsheet Description*, provides an estimated flowsheet for the C tank farm waste retrieval process based upon this planning. However, there are numerous possible combinations of which single-shell tanks can go to which double-shell tanks (DSTs) and in which order. These combinations are further complicated with the retrieval of other C farm tanks not included in this tank waste retrieval work plan. It is impractical to provide flowsheets and preliminary risk evaluations that look at all possible combinations of tanks and tank retrieval order when the end result is not expected to cause any significant change in the risk associated with the overall waste retrieval process. Therefore, the dotted lines in Figures D-1, D-2, and D-3 provide the calculated risk impacts for an 8,000-gal. retrieval leak based upon the retrieval plan in Section 3.1.1, and an assumed worst case 8,000-gal. retrieval leak.

The base case 8,000-gal. leak uses concentrations obtained from RPP-21753, with the sluicing supernate coming from the DSTs specified in Section 3.1.1. The assumed worst case 8,000-gal. leak for technetium-99 is based upon sluicing with a technetium-99 concentration of 8.3×10^{-5} Ci/L. The assumed worst case 8,000-gal. leak for chromium is based upon sluicing with a chromium concentration of 2.3 g/L. The assumed worst case 8,000-gal. leak for nitrite is based upon sluicing with a nitrite concentration of 43 g/L.

The worst case technetium-99 concentration assumes sluicing with tank AY-101 supernate following waste retrieval from tank C-112. The worst case chromium concentration assumes sluicing with tank AY-101 supernate only (the tank AY-101 supernate chromium concentration is sufficiently high that the supernate chromium concentration will be reduced as single-shell tank waste retrieval proceeds). The worst case nitrite concentration assumes sluicing with tank AY-101 supernate following waste retrieval from tanks C-104 and C-107. The worst case concentrations are estimates only and can vary with the amount of raw water added during waste retrieval or a number of other factors. The worst case concentrations are not based upon any planned waste retrieval sequence, they just represent more restrictive mixes of the five single-shell tanks with a receiver DST for the tanks discussed in this tank waste retrieval work plan.

Should the retrieval plan vary from that in Section 3.1.1, the Washington State Department of Ecology will be notified of the change via a change notice form, per Section 9.3 of the HFFACO Action Plan. A retrieval plan variation means: (1) altering the designated DST receiver tank for a given single-shell tank, or (2) making transfers from DSTs other than those listed in Section 3.1.1 into one of the Section 3.1.1 receiver DSTs, which will result in key indicator contaminant concentrations in the receiver DST liquid phase greater than those specified in RPP-21753 for the starting DST supernate concentration. A statement will be included on the change notice form that the estimated risk associated with the revised waste retrieval plan is bounded by the assumed worst case impact shown in Figures D-1, D-2, and D-3. Alternatively, if the 8,000-gal. retrieval leak risk for a revised retrieval plan may not be bounded by the assumed worst case impact shown in Figures D-1, D-2, and D-3, revised risk impacts will be provided.

hypothetical volume used only as a point of reference and for consistency with previous analyses. It was not intended to represent anticipated retrieval leak volumes or leak detection limits for tank C-112.

The planning for tanks C-102, C-104, C-107, C-108, and C-112 waste retrieval as of mid March 2005 is given in Section 3.1.1. RPP-21753, *C-Farm 100 Series Tanks, Retrieval Process Flowsheet Description*, provides an estimated flowsheet for the C tank farm waste retrieval process based upon this planning. However, there are numerous possible combinations of which single-shell tanks can go to which double-shell tanks (DSTs) and in which order. These combinations are further complicated with the retrieval of other C farm tanks not included in this tank waste retrieval work plan. It is impractical to provide flowsheets and preliminary risk evaluations that look at all possible combinations of tanks and tank retrieval order when the end result is not expected to cause any significant change in the risk associated with the overall waste retrieval process. Therefore, the dotted lines in Figures E-1, E-2, and E-3 provide the calculated risk impacts for an 8,000-gal. retrieval leak based upon the retrieval plan in Section 3.1.1, and an assumed worst case 8,000-gal. retrieval leak.

The base case 8,000-gal. leak uses concentrations obtained from RPP-21753, with the sluicing supernate coming from the DSTs specified in Section 3.1.1. The assumed worst case 8,000-gal. leak for technetium-99 is based upon sluicing with a technetium-99 concentration of 8.3×10^{-5} Ci/L. The assumed worst case 8,000-gal. leak for chromium is based upon sluicing with a chromium concentration of 2.3 g/L. The assumed worst case 8,000-gal. leak for nitrite is based upon sluicing with a nitrite concentration of 43 g/L.

The worst case technetium-99 concentration assumes sluicing with tank AY-101 supernate following waste retrieval from tank C-112. The worst case chromium concentration assumes sluicing with tank AY-101 supernate only (the tank AY-101 supernate chromium concentration is sufficiently high that the supernate chromium concentration will be reduced as single-shell tank waste retrieval proceeds). The worst case nitrite concentration assumes sluicing with tank AY-101 supernate following waste retrieval from tanks C-104 and C-107. The worst case concentrations are estimates only and can vary with the amount of raw water added during waste retrieval or a number of other factors. The worst case concentrations are not based upon any planned waste retrieval sequence, they just represent more restrictive mixes of the five single-shell tank s with a receiver DST for the tanks discussed in this tank waste retrieval work plan.

Should the retrieval plan vary from that in Section 3.1.1, the Washington State Department of Ecology will be notified of the change via a change notice form, per Section 9.3 of the HFFACO Action Plan. A retrieval plan variation means: (1) altering the designated DST receiver tank for a given single-shell tank, or (2) making transfers from DSTs other than those listed in Section 3.1.1 into one of the Section 3.1.1 receiver DSTs, which will result in key indicator contaminant concentrations in the receiver DST liquid phase greater than those specified in RPP-21753 for the starting DST supernate concentration. A statement will be included on the change notice form that the estimated risk associated with the revised waste retrieval plan is bounded by the assumed worst case impact shown in Figures E-1, E-2, and E-3. Alternatively, if the 8,000-gal. retrieval leak risk for a revised retrieval plan may not be bounded by the assumed worst case impact shown in Figures E-1, E-2, and E-3, revised risk impacts will be provided.